Integrated SOA Based Add-Drop Multiplexer for WDM Optical Packet Routing with Reduced Distortion Penalty

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Abstract: A monolithic two-input, two-output add-drop multiplexer is demonstrated for low latency, wavelength-striped, optical packet switching applications. Multi-wavelength routing is demonstrated with mitigated distortion penalty.

OCIS codes: (140.5960) Semiconductor lasers; (060.2330) Fiber optics communications

1. Introduction

Increasing data transmission rates in server interconnections are driving requirements for higher capacity and lower cost optical routing technologies. Wavelength division multiplexing (WDM) and in particular wavelength striping [1] can be used to achieve lower latency [2]. Optical switch fabrics which are capable of routing blocks of wavelengths with nanosecond switching times are a key technology for switched optical data networks. SOA based switches [3] may operate in a lossless regime but are prone to distortion induced penalties at the high input powers required in switched optical ring and mesh topologies. We demonstrate low-penalty WDM operation in a lossless operating regime with high crosstalk suppression in an integrated SOA based add-drop multiplexer.

The add-drop multiplexer shown in figure 1 comprises short matched SOAs to allow path independent gain, reduced power consumption and low footprint (850µm x 850µm). Standard ridge waveguide laser fabrication technology is used, prior to multiple p-side electrode definition and the etching of total internal reflection (TIR) mirrors. Each of the four input guides expand to 1x2 splitters which comprise 45º TIR mirrors and perpendicular pairs of interconnecting SOA gates.

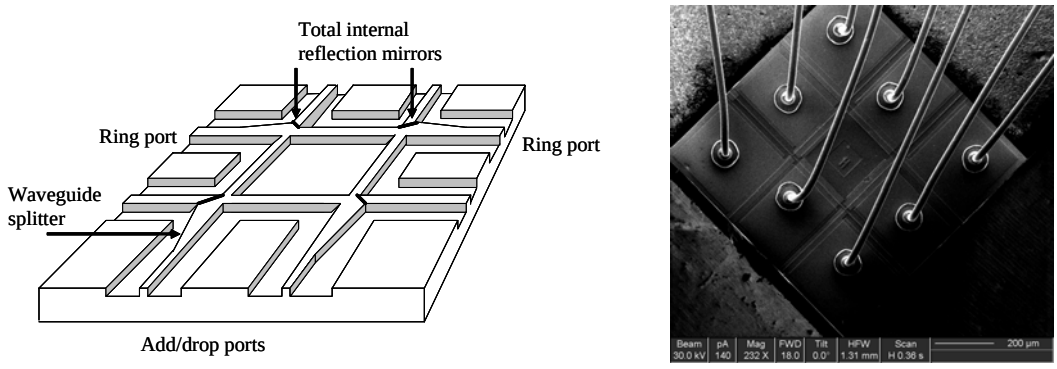

Figure 1: Schematic diagram of integrated add drop multiplexer with SEM of fabricated device

2. Experimental details

The ADM is operated with -6dBm aggregate input chip power and initially with sufficient chip gain of 4-6dB to achieve lossless switching. The WDM test-scheme comprises a four-wavelength source centered at 1550nm with 200GHz spacing modulated with decorrelated 2.488Gb/s data. This is aggregated with an arrayed waveguide grating prior to launch into the switch ports. No error floors are observed for the operating currents of 20mA, and

power penalty performance is summarised by wavelength and path in table 1. For the ring path, where the facets are AR coated, penalties from 0.0-0.3dB are measured. This degrades, however, on both the add and drop paths. This degradation is attributable to the 2dB gain ripple on the cleaved add and drop outputs. The crosstalk performance is very high with all configurations of the switch giving >40dB suppression.

	Output	Add	Drop
λ1	0.0 dB	0.6 dB	0.4 dB
λ2	0.3 dB	0.4 dB	0.8 dB
λ3	0.0 dB	0.5 dB	0.9 dB
λ4	0.2 dB	1.2 dB	0.8 dB

Table 1: Error penalties at 10^{-9} for output, add and drop paths at 20mA per SOA

For an increased operating current of 30mA per gate, the on-chip gain (net of splitter losses) is increased to 12dB, but a degraded wavelength-dependent power penalty of 0.6-3.3dB is measured. This distortion and gain ripple induced penalty is readily mitigated by reducing the input optical power, but this limits the wavelength channel number.

In data networking, coding schemes such as 8B10B are widely implemented to relax transceiver electronic performance requirements [4]. Applying such data encoding in an optical switch increases the frequency of transitions thus can reduce the penalty due to long one and zero patterns. Figure 2 shows the effect on penalty of pattern length and wavelength number. As expected the penalty reduces with shorter patterns. However it also unexpectedly reduces with increased wavelength number. This can also be attributed to a higher transition rate derived from the high number of wavelength, each of which is carrying uncorrelated, asynchronous data.

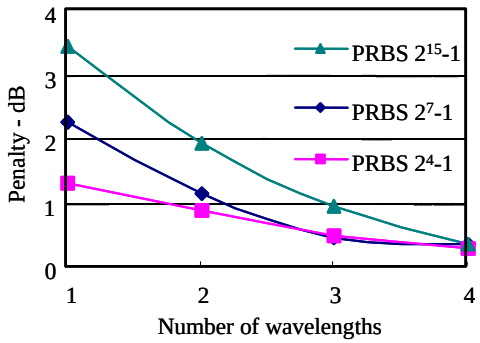

Figure 2. Variation of Penalty with number of wavelengths at 26mA per SOA

4. Conclusions

A fully integrated SOA based add-drop multiplexer is demonstrated for WDM networking applications. The switch facilitates low power switching of wavelength compressed packets with lossless operation, low crosstalk and low distortion penalty.

5. References

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